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Cultural Differences in the Age-related Positivity Effect: Distinguishing between Preference and Effectiveness

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Abstract

Prior studies have found mixed results regarding whether there are cultural differences in the age-related positivity effect, defined as older adults showing a greater bias in cognitive processing for positively over negatively and neutrally valenced information relative to younger adults. This study attempted to address this controversy by examining visual attention toward culturally relevant versus irrelevant pictures that differed in valence among younger and older US Americans and Hong Kong Chinese. Preferences (attentional biases toward particular valence) and effectiveness (whether the attentional biases are associated with better mood) were also distinguished. Findings revealed that regardless of cultural relevance of the pictures, older US Americans showed more gaze preference for positive over negative pictures compared to younger adults; this age difference was not found among Hong Kong Chinese. In contrast, older Hong Kong Chinese showed better mood as a function of more gaze preference for positive over negative pictures. Younger Hong Kong Chinese, and younger and older US Americans did not show this association. The results suggest that an age-related positivity effect exists at the preference level for US Americans, but at the effectiveness level for Chinese.

Keywords: positivity effect; culture; eye-tracking; preference; effectiveness

Cultural Differences in the Age-related Positivity Effect: Distinguishing between Preference and Effectiveness

Research on the interplay between human emotion and cognition has robustly demonstrated the negativity dominance effect — negative stimuli are better cognitively processed compared to positive and neutral stimuli (for a review, see Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001). This research typically recruits younger adults as participants. Research targeting older adults, however, often reveals an age-related positivity effect — older adults show a greater bias in cognitive processing for positive over negative and neutral information (for reviews, see Reed & Carstensen, 2012; Reed, Chan, & Mikels, 2014). For example, older adults pay more attention to positive than negative information (e.g., Isaacowitz, Wadlinger, Goren, & Wilson, 2006) and also remember positive information better than negative information (e.g., Charles, Mather, & Carstensen, 2003) relative to younger adults. There has been a controversy, however, concerning whether there are cultural differences in the age-related positivity effect. Some studies replicated the above pattern of age-related positivity effect in the US, South Korea and Mainland China (Chung & Lin, 2012; Gong, Fu, Wang, Franz, & Long, 2014; Ko, Lee, Yoon, Kwon, & Mather, 2011; Kwon, Scheibe, Samanez-Larkin, Tsai, & Carstensen, 2009; Wang, He, Jia, Tian, & Benson, 2015; Zhang, Liu, Wang, Ai, & Luo, 2016), suggesting the phenomenon may be universal. Yet, other studies did not find the pattern among Hong Kong Chinese (Fung, Isaacowitz, Lu, Wadlinger, Goren, & Wilson, 2008; Fung & Tang, 2005).

This study aimed at shedding light on the controversy by testing whether Hong Kong Chinese and US adults would each show the age-related positivity effect only when the stimuli were culturally relevant. In addition, this study also shed light on the controversy by

distinguishing between two distinct aspects of the age-related positivity effect (see Isaacowitz & Blanchard-Fields, 2012): (1) whether there are age differences in cognitive processing, what is termed "preference", and (2) whether such differential cognitive processing leads to emotional consequences for the age groups, what is termed "effectiveness". As discussed below, we predicted that the first aspect would be more likely to occur among US Americans and the second aspect would be more likely to occur among Hong Kong Chinese.

Cultural Differences in the Age-related Positivity Effect

The age-related positivity effect was first observed in studies on socioemotional selectivity theory (SST: Carstensen, Fung, & Charles, 2003). The theory argues that as people age, they perceive their future time as increasingly limited. This sense of anticipated ending motivates them to shift their prioritization from future-oriented goals (e.g., a professor may seek to publish in a top-tier journal to advance her career) to emotionally meaningful goals (e.g., the same professor may seek to do a study that is meaningful to her regardless of whether it will be published). This shift in goals leads people to favor positive over negative stimuli in cognitive processing as they age (for a review, see Reed & Carstensen, 2012).

However, as the age-related positivity effect was studied in many more cultures, it became clear that (for reviews, see Reed & Carstensen, 2012; Reed, Chan, & Mikels, 2014) the age-related positivity effect was more reliably found in Western cultures (mostly the US culture) where positively valenced stimuli (e.g., praises) were typically deemed more meaningful than negatively valenced stimuli (e.g., criticisms) in promoting Western values such as personal achievement, self-esteem, autonomy and uniqueness (Markus & Kitayama, 1991). The results were more mixed in Asian cultures. Some of them found the positivity effect. For example, older

Mainland Chinese and Koreans showed enhanced attention and memory for positive over negative stimuli compared to their younger counterparts (Chung & Lin, 2012; Gong et al., 2014; Ko et al., 2011; Kwon et al., 2009; Wang et al., 2015; Zhang et al, 2016). Some other studies did not. For example, older Hong Kong Chinese paid equal, or even more attention to negative than positive stimuli compared to their younger counterparts (Fung et al., 2008; Fung & Tang, 2005). Fung and colleagues (Fung et al., 2008; Fung, Isaacowitz, Lu, & Li, 2010) argued that this might be the case because paying attention to negative cues was more critical for the maintenance of interpersonal harmony valued in these cultures (Kwan, Bond, & Singelis, 1997; Markus & Kitayama, 1991; Uchida, Norasakkunkit, & Kitayama, 2004). Supporting their argument, they (Fung, et al., 2010) found that the age-related positivity effect was found among Chinese who were less interdependent but not among those who were more interdependent. Again, they interpreted this finding as suggesting that the latter group valued interpersonal harmony more than the former group, and thus continued to find negative cues useful with age.

Cultural Relevance

In addition to valence, personal/cultural relevance may be another factor that determines age differences in cognitive processing. Indirect evidence for this hypothesis comes from the social psychological literature. Culture-relevance is an extension of self-relevance (Hong, Ip, Chiu, Morris, & Menon, 2001; Hong, Morris, Chiu, & Benet-Martinez, 2000). Both Social Identity Theory and Social Categorization Theory (Ashforth & Mael, 1989; Tajfel & Turner, 1979; Turner, Hogg, Oakes, Reicher, & Wetherell, 1987) assert that individuals define themselves not only by individuated identity but also by collective social identity, such as group membership, ethnicity, and culture. Individuals also spontaneously tend to categorize social

information into different social categories (e.g., ingroup and outgroup based on their group membership), and highlight the boundaries between social categories (Brewer, 1991; Turner & Reynolds, 2010).

It is well known that self-relevant information usually is perceived as more meaningful and is more highly prioritized in human cognition compared to self-irrelevant information (Farb et al., 2007; Rogers, Kuiper, & Kirker, 1977; Schmitz & Johnson, 2007; Symons & Johnson, 1997). As an extension of self-relevance, culture-relevance should also be perceived as meaningful, and thus prioritized in human cognition (Fung, 2013). Empirical evidence supports the priority of social-self relevant (e.g., culture-relevant) information (Brewer, 1991; Turner & Reynolds, 2010). Individuals usually cognitively favor information relevant to social identities and categories that they identify with (Johnson et al., 2002; Kesebir & Oishi, 2010; Lee, Rosa, & Gutchess, 2015; Leshikar, Dulas, & Duarte, 2015; Leshikar & Gutchess, 2015; Leshikar, Park, & Gutchess, 2015). To the extent that older people find culturally relevant information more emotionally meaningful than culturally irrelevant information, we hypothesize that the age-related positivity effect would occur to a *greater* extent for culturally relevant than culturally irrelevant stimuli.

Nevertheless, an alternative hypothesis exists. The age-related positivity effect might occur to a *lesser* extent for culturally relevant than irrelevant stimuli, because the former stimuli are so important that the individual does not want to miss any of them. Supporting this hypothesis, prior studies found that the age-related positivity effect in health-related decision making showed up only among people with better health, but not among people with poorer health (English & Carstensen, 2015). The authors claimed that this was the case because older adults with poorer health did not discriminate between positively and negatively valenced health

information "when the stakes were high (English & Carstensen, 2015, pp. 350)." Similarly, when both positive and negative information were made personally relevant, the age-related positivity effect disappeared (Tomaszczyk, Fernandes, & MacLeod, 2008). To the extent that cultural relevance operates in similar ways as self-relevance, these findings hint at the possibility that the age-related positivity effect might occur to a lesser extent for culturally relevant than irrelevant stimuli.

Preference versus Effectiveness

In addition, cultural differences might occur at different processes of the age-related positivity effect. The effect at least involves two processes: 1. Older adults show superior cognitive processing preferences toward positively valenced stimuli over other stimuli relative to younger adults (we call this process "preference"); 2. Older adults benefit more (e.g., more positive mood changes) from cognitively processing positively valenced stimuli relative to younger adults (we call this process "effectiveness"). The aging literature usually does not distinguish between these two processes (see Isaacowitz & Blanchard-Fields, 2012 Table 1 for a list of quotations that link the positivity effect to emotion regulation). One exception was Livingstone and Isaacowitz (2015) who directly distinguished between preference and effectiveness in age differences in situational selection (freely choose to engage in positive, neutral, or negative materials) and situational modifications (choose to view or skip positive and negative materials). They found age differences in the use of situational selection and modification, with older adults selecting more positive and neutral materials over negative, and skipping more negative than positive material, relative to younger adults. Yet, they did not find any age differences in effectiveness. Regardless of age, people who chose to engage more with

positive materials had better mood. When we make a similar distinction and organize the literature on the age-related positivity effect as such, we observe that there is much more empirical evidence for the preference process (see Scheibe & Carstensen, 2010 for a review) than for the effectiveness process (Isaacowitz, Toner, & Neupert, 2009; Noh, Lohani, Isaacowitz, 2011 are among the few examples) among US Americans.

In this study, we attempted to explore whether the age-related positivity effect might be more likely to occur (1) at the preference level among US Americans than Hong Kong Chinese, but (2) at the effectiveness level among Hong Kong Chinese than US Americans. This preference vs. effectiveness speculation was based on some recent findings on cultural differences in affect valuation and emotion regulation. For instance, US Americans typically desire high-arousal positive affect, although the strength of this desire may attenuate with age (Scheibe, English, Tsai, & Carstensen, 2013; Tsai, Knutson, & Fung, 2006). To achieve their desired emotional states, US Americans tend to downregulate negative and upregulate positive affect; and this tendency is stronger among older versus younger US Americans (Nashiro, Sakaki, & Mather, 2012; Sim et al., 2015).

East Asians, in contrast, typically desire low-arousal positive affect and a balance between positive and negative affect (Miyamoto & Ma, 2011; Tsai et al., 2006). They engage in hedonic emotion regulation less, in general, compared to Westerners (Miyamoto & Ma, 2011). When engaged in emotion regulation, they are more likely to downregulate negative affect, sometimes even downregulate positive affect, and less likely to upregulate positive affect compared to Westerners (Chung & Lin, 2012; Ma, Li, Niu, Yu, & Yang, 2013; Miyamoto & Ma, 2011). Given that US Americans, particularly older Americans, are more likely than their East Asian counterparts to seek to upregulate positive affect, they may be more likely to display the

age-related positivity effect, or show the preference, as a means to try to achieve their desired emotional states.

Empirical evidence has also revealed less age differences in usage of other emotion-regulation strategies among the Chinese than the US Americans. For example, Gross and John (2003) found among US Americans that older adults used less emotional suppression to regulate their emotions than did younger adults, but we did not find such age differences in emotional suppression among Hong Kong Chinese (Yeung & Fung, 2012). If the age-related positivity effect is indeed an emotion regulatory strategy, then it is reasonable to speculate that the lack of age differences in emotion regulation could contribute to an absence of the age-related positivity effect among Hong Kong Chinese (Fung et al., 2008; Fung & Tang, 2005).

We further argue that the age-related positivity effect at the effectiveness level may be more likely to occur among Hong Kong Chinese than US Americans. In other words, we predicted that once older Hong Kong Chinese engaged in the positivity effect, they would benefit more from it than would their younger counterparts, and such age differences would be more likely to occur among Hong Kong Chinese than US Americans. Recently, a cross-cultural study has shown that motivation to pursue happiness predicts lower well-being in a US sample, but higher well-being in a Russian and an East Asian sample (Ford, Dmitrieva, et al., 2015). This finding suggests that, although less likely to engage in pro-hedonic emotion regulation than are Westerners (Miyamoto & Ma, 2011), East Asians are more likely to derive benefits once they do so. Our own previous study (Wong, Gong, & Fung, under review) further revealed that older Chinese were more likely to get benefits from valuing and pursuing happiness compared to younger Chinese. Moreover, in an earlier study (Yeung & Fung, 2012), we found among Hong Kong Chinese that greater use of suppression at work was associated with lower intensity of

negative emotions among older adults, whereas such association was not found among younger adults. Greater use of suppression was significantly predictive of sales productivity of older workers, but such a positive association was not shown in younger workers. In contrast, use of suppression was associated with negative outcomes for both younger and older Americans (Gross & John, 2003). These findings, taken together, lead to speculation that older East Asians (in our case, Hong Kong Chinese) would affectively benefit more than their younger counterparts from engaging in pro-hedonic emotion regulation, and this age difference may occur to a less extent among US Americans.

The Present Study

This study attempted to shed light on the controversy regarding cultural differences in the age-related positivity effect by presenting younger and older US Americans and Hong Kong Chinese with pictures of different valence and different cultural relevance. We aimed at addressing two research questions: First, whether valence and cultural relevance interacted in predicting age differences in attention in the two cultural groups; second, whether these interactions operated similarly at the preference and effectiveness levels.

For the first research question, we tested the two alternative hypotheses about the moderating role of cultural relevance in the age-related positivity effect by manipulating the cultural relevance of the stimuli. In both Charles and colleagues (2003) and our prior study (Fung et al., 2010) on the age-related positivity effect, participants were presented with 32 (16 neutral: 8 positive and 8 negative) pictures, taken from the International Affective Picture System images (IAPS; Lang, Bradley, & Cuthbert, 1999). We noticed that many of the pictures are culturally specific, mostly relevant to the European culture. For instance, almost all characters are

Caucasian. The activities the pictures feature are typically European/Western, like gathering around a fireplace or burying in a tomb with a cross on top. To address this limitation, in this study, we selected two sets of pictures, such that one set was more relevant to the European American culture and one to the Chinese culture. We tested whether US Americans and Hong Kong Chinese would each show the age-related positivity effect in visual attention depending on whether the valenced stimuli were culturally relevant.

For the second research question, we tested these valence-by-cultural relevance interactions on age-related attention for the two cultural groups at the preference versus effectiveness levels. We predicted that, compared with Hong Kong older adults, US older adults would be more likely than their younger counterparts to show attentional preferences toward more positively valenced and more culturally relevant pictures. Conversely, although older adults of both cultures would have more positive mood changes, relative to their younger counterparts, when they showed a higher level of attention toward more positively valenced and more culturally relevant pictures, we predicted that Hong Kong Chinese would show these age differences in effectiveness to a greater extent than US Americans would.

In addition, prior studies on the age-related positivity effect were often conducted without mood induction (Reed et al., 2014). Yet, without creating a need to do mood repair, age differences in visual attention may not lead to changes in mood (Isaacowitz, Toner, Goren, & Wilson, 2008). To enhance participants' motivation to engage in emotion regulation during picture viewing, we experimentally manipulated participants' mood (negative or neutral mood) before they saw the pictures. This manipulation allowed us to test whether the above predictions would be more pronounced when participants were in a negative or neutral mood, enabling us to

explore whether the cultural differences in age-related positivity effect, if observed, were attributable to emotion regulation.

Method

Participants

A group of US and Hong Kong Chinese adults provided data in the current study. The US sample included 117 older (M_{age} = 68.68, SD = 6.86; 58 females; educational level: 2.6% were primary school level, 21.4% secondary school level, 39.3% Bachelor level, and 36.6% postgraduate level) and 100 younger adults who were native English speakers (M_{age} = 19.48, SD_{age} = 2.33, 63 females; educational level: 32.0% were secondary school level, 66.0% Bachelor level, and 2.0% postgraduate level). The Hong Kong sample included 65 older (M_{age} = 72.09, SD_{age} = 5.17, 39 females; educational level: 10.8% were lower than primary school, 43.1% primary school level, 40.0% secondary school level, and 6.2% Bachelor level) and 93 younger Chinese adults (M_{age} = 19.77, SD_{age} = 1.82, 53 females; educational level: 1.1% were primary school level, 5.4% secondary school level, 87.1% Bachelor level, and 6.5% postgraduate level). Older adults at both sites were recruited from a subject pool or from the community in the same geographic areas as the universities where the study was conducted, and they received monetary compensation for their participation. Younger adults at both sites participated for credit as part of their Introductory Psychology courses. Among participants included in the study, 86 older adults and 91 younger adults from the US sample, and 49 older adults and 76 younger adults from the Hong Kong sample had recorded eye-tracking data. Participants who had no recorded data had reflective eyewear that interfered with the cornea reflection recording or had obfuscation of the pupil due to various characteristics of their eyes (e.g., droopy eyelids or cataract). A power analysis suggests that, assuming small effect size (eta-squared = .01, Cohen's f = .10), alpha = .05,

power = .8, and r = .7 among repeated measures (in our case, across trials), a total sample size of 168 (42 participants for each US and HK age group) was needed for the study. Our sample size satisfied this criterion. Ethics approvals were received from the Survey and Behavioral Research Ethics Committee, Chinese University of Hong Kong and the Northeastern University Institutional Review Board.

Apparatus, Materials, and Procedure

Eye-tracking. Gaze (attention) of the participants was tracked by ASL EYE-TRAC 6 Desktop Remote Eye Tracker with Magnetic Head Tracking. It records the duration and location of the participants' left eye 60 times per second. The eye tracker defines visual fixations as the time in which a participant focuses his/her gaze within one degree of visual angle on a location for 100 ms or more, within pre-designated Areas of Interest (AOI) locations. All stimuli were presented as pictures on a 15-inch computer monitor located approximately 20 inches from the head of participants.

Stimuli. We prepared 69 pairs of affective pictures, including 69 pieces relevant to Western cultures and 69 pieces relevant to Chinese culture. The Western pictures were taken from the International Affective Picture System (Lang et al., 1999) and Chinese pictures from open sources from the web. The Western picture and Chinese picture in each pair had equivalent content. For example, a negative Western picture shows Caucasian-looking individuals running away from a fire, and its corresponding Chinese picture shows Asian-looking individuals doing the same. A neutral Western picture shows a pair of hands playing chess and its corresponding Chinese picture shows a pair of hands playing Chinese chess. Four hundred ninety participants (17 to 71 years), comprising 249 Hong Kong Chinese and 241 European Americans, from a

university-based online subject pool and Amazon Mechanical Turk respectively rated these pictures on a scale from 1 to 9 for the following dimensions: valence (1 = "unhappy" to 9 = "happy"), arousal (1 = "calm" to 9 = "excited"), and cultural relevance (1 = "relevant to Western culture" to 9 = "relevant to Chinese culture").

Nineteen pairs of pictures, including 5 pairs of positive, 6 pairs of negative, and 8 pairs of neutral pictures, were selected for the experiment. The ratings for these pictures are displayed in Table 1. A 2 (picture's cultural relevance: Chinese vs. Western) × 3 (picture's emotional valence: positive, neutral, vs. negative) × 2 (participant's cultural background: Chinese vs. US) ANOVA was conducted for each of these dimensions. The results, as expected, showed that Chinese rated Chinese pictures and European Americans rated Western pictures to have higher scores on cultural relevance, $F(1,32) = 151.39$, $p < .001$, $\eta^2 = .83$; positive pictures had higher valence scores than neutral pictures, and neutral pictures had higher valence scores than negative pictures, $F(1,32) = 86.27$, $p < .001$, $\eta^2 = .84$; positive and negative pictures had higher arousal scores than neutral pictures, $F(1,32) = 7.53$, $p = .002$, $\eta^2 = .32$. All other effects were nonsignificant, except that neutral pictures had higher scores on cultural relevance than did positive and negative pictures, $F(1,32) = 9.32$, $p = .001$, $\eta^2 = .37$, and the US sample had higher valence scores for Chinese pictures compared to the Chinese sample, $F(1,32) = .5.95$, $p = .02$, $\eta^2 = .16$. In addition to these stimuli, we also presented 7 culturally and emotionally neutral pictures as fillers to the participants; these fillers were not included for data analyses. These neutral fillers were included in order to roughly match the number of neutral pictures with that of emotional (positive and negative) pictures.

Measures. To ensure that participants could reliably view the stimuli, all participants completed Snellen chart for visual acuity (Snellen, 1862) and the Pelli-Robson Contrast

Sensitivity Chart (Pelli, Robson, & Wilkins, 1988). Additional measures included the subjective health, Wahler Physical Symptoms Inventory (WPSI; Wahler, 1983) and the Wechsler Digit Span Test (Wechsler, 1981). Moreover, future time perspective has been found to influence socioemotional selectivity (e.g., Fung & Carstensen, 2006). Self-construal has been found to moderate the age-related positivity effect (Fung et al., 2010) and attention functioning has been found to moderate the mood outcome of the positivity effect (Isaacowitz et al., 2009). We thus included the Future Time Perspective Scale (FTP; Carstensen & Lang, 1996, as used in Fung, Lai, & Ng, 2001), Self-Construal Scale (SCS; Gudykunst et al., 1996), and the Attention Network Test (ANT; Fan, McCandliss, Sommer, Raz, & Posner, 2002) in the study. As participants from the US could come from a variety of ethnic backgrounds, and younger adults in Hong Kong might be more familiar with US culture than older adults, we included the Vancouver Index of Acculturation (VIA; Ryder, Alden, & Paulhus, 2000) to measure levels of familiarity with US and Chinese cultures in both U.S. and Hong Kong samples. As the study involves mood induction and thus possible spontaneous emotion regulation in participants, we also measured emotion regulation behaviors with the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003).

Procedures. After informed consent, participants completed the battery of questionnaires (demographic information, ERQ, FTP, SCS, WPSI) and the eye tests. Participants then were calibrated for the eye-tracker and began the experiment by watching a short video clip. Participants were randomly assigned to either the neutral condition or the negative-mood condition. In the neutral condition, participants watched a soundless, emotionally-neutral clip of natural scenery. In the negative-mood condition, participants watched negative-mood provoking

clip "death of Mufasa" from the movie "The Lion King," which has been validated and recommended by Rottenberg, Ray, and Gross (2007) and Livingstone and Isaacowitz (2015).

After watching the clips, participants rated the valence and arousal of their current mood on 5-point scales (for valence: 1 = "unhappy" to 5 = "happy"; for arousal: 1 = "calm" to 5 = "excited"). If participants rated their mood as not negative (i.e., with scores equal or higher than 3), the experiment would then automatically proceed to play evocative music using the Eich continuous music technique (CMT; Eich & Metcalfe, 1989) to further induce negative mood in the participants. In order to make the mood induction more effective, we asked the participants to recall personal sad memories when they were listening to the music. The participants were free to stop the music when they felt sad, and then recorded their mood on the 5-point rating scales. However, if they still did not feel sad by the end of the music, they simply recorded their mood and proceeded with the rest of the experiment.

Data from participants who were not successfully induced into a negative mood were not included in subsequent analysis (12 participants, including 9 US older adults, 1 Hong Kong younger adult, and 2 Hong Kong older adults, were excluded because their ratings of mood valence were equal to or larger than 3 after the second round of mood induction). No positive-mood condition was included in the study because studies of the age-related positivity effect have found no difference between the positive-mood and control conditions (Isaacowtiz et al., 2009).

After the mood induction, the 38 pictures (as described above in the *stimuli* section) were intermixed with 7 neutral fillers (affectively and culturally neutral pictures from the IAPS), and then were presented, one piece each time, on the screen in random order. Participants were instructed to view these pictures, and their gazes towards the pictures were recorded. The AOIs

were set in such a way to ensure that we tracked participants' gaze toward the most emotion-eliciting parts of the picture. For example, for a picture of a girl smiling, the AOI was set to cover the face of the girl. After viewing each picture, participants rated the valence and arousal of their mood at the time on 5-point scales (for valence: 1 = "unhappy", 5 = "happy"; for arousal: 1 = "calm", 5 = "excited"). After participants had completed the picture viewing task, they were administered the Digit Span Test, the Attention Network Task, and the VIA.

Data Analysis

As pictures and participants were crossed (all participants saw all pictures) in the experiment, cross-random multi-level models were built to control for inter-participant and inter-picture random effects when examining the effects of interested independent variables, including picture valence (i.e., pictures' emotional valence from the rating phase of the current study; as a continuous variable and was grand-mean centered), picture relevance (i.e., pictures' cultural relevance; relevant to Chinese culture vs. relevant to Western culture), age (i.e., younger vs. older adults), culture (i.e., participant' cultural background; Chinese vs. US), and mood condition (negative-mood condition vs. neutral-mood condition). The outcome variables were participants' fixation duration percentage and mood valence after viewing pictures. Fixation duration was measured as the percentage of time the participant fixated (each fixation was at least 100ms) on any point within the pre-defined, pre-normed areas of interest within each picture, out of the entire period the participant spent looking at the picture. Trials with more than 80% fixation duration outside the areas of interest were excluded, as it indicates inattention to the experiment or bad data recording quality. Filler trials were also excluded from all analyses, leaving (a

maximum of, if all trackable) 38 trials for each participant. The final data included 282 participants with 6909 observations in total.

The analyses were performed by lme4 (Bates, Maechler, & Bolker, 2015) for R (R Core Team, 2017). P-values were obtained using package lmerTest (Kuznetsova, Brockhoff, & Christensen, 2016), which used the Satterthwaite approximation to estimate degrees of freedom.

Results

Descriptive Results

The characteristics of different groups measured by self-report questionnaires are displayed in Table 2. The results of 2 (age: younger vs. older) × 2 (participant culture: Hong Kong Chinese vs. US) ANOVAs showed a significant main effect of participant culture on subjective health, $F(1, 367) = 71.09$, $p < .001$, $\eta^2_p = .16$, revealing higher levels of subjective health reported by US than Hong Kong Chinese participants. The results also showed significant interaction of age and participant culture on visual acuity, $F(1, 369) = 23.38$, $p < .001$, $\eta^2_p = .06$, cognitive ability, $F(1, 371) = 5.61$, $p < .05$, $\eta^2_p = .02$, expressive suppression, $F(1, 368) = 9.12$, $p < .01$, $\eta^2_p = .02$, interdependent self-construal, $F(1, 371) = 48.59$, $p < .001$, $\eta^2_p = .12$, physical symptom, $F(1, 367) = 79.55$, $p < .001$, $\eta^2_p = .18$, and acculturation towards the other culture, $F(1, 342) = 41.26$, $p < .001$, $\eta^2_p = .11$. Post hoc tests revealed that US older adults had lower scores on visual acuity and expressive suppression, Chinese younger adults had higher scores on cognitive ability, and Chinese older adults reported lower scores on physical symptoms compared to the other age groups; Chinese older adults scored higher than US older adults on interdependent self-construal. For acculturation, while each group, regardless of age, was more acculturated into its own culture than the other culture, younger Chinese were more acculturated into the other

culture than were their older counterparts. Such age differences were not found among US Americans.

To ensure that the mood manipulation was effective, participants under the negative-mood condition were allowed to enter the main task of viewing picture only when their self-reported mood valence was lower than 3 (on a 5-point Likert scale from 1 = very negative to 5 = very positive). Participants' self-reported mood valence before and after mood induction are displayed in Table 2. Two (age: younger vs. older) × 2 (participant culture: Hong Kong Chinese vs. US) × 2 (mood condition: negative vs. neutral) ANOVAs on mood after induction showed a significant main effect of experimental condition, no matter whether mood before induction was controlled for, $F(1, 315) = 1190.14$, $p < .001$, $\eta^2_p = .79$, or not controlled for, $F(1, 314) = 1193.27$, $p < .001$, $\eta^2_p = .79$. The results indicated that participants under the negative-mood condition reported more negative mood compared to their counterparts under the neutral-mood condition. All other main and interaction effects did not reach significance (ps > .05). These results demonstrated the effectiveness of the mood induction.

Correlational analyses between these measures and the outcome measures of our interest (i.e., fixation duration percentage and mood ratings) showed that none of these variables significantly correlated with fixation duration percentage (ps > .05), but five of them correlated with mood ratings, including cognitive ability ($r = -.11$, $p < .05$), FTP ($r = .14$, $p < .01$), cognitive reappraisal ($r = .17$, $p < .01$), physical symptom ($r = -.12$, $p < .05$), and baseline mood valence before mood-induction ($r = .28$, $p < .001$). These variables were statistically controlled for in the follow-up analyses on mood ratings.

Age Differences in Gaze Fixation (Preference)

A cross-random multi-level model was built for fixation duration percentage. The predictors in this model included multiple fixed effects and random effects. The fixed effects included the main effects and all interactions of age, culture, picture valence, picture relevance, and mood condition. Pictures' arousal rating and AOI ratio (i.e., ratio of area of AOI to area of the whole picture) were also included as fixed effects so that their effects were controlled for. Random effects, which modeled inter-participant and inter-picture variance, included intercepts for participants and individual pictures, as well as by-participant random slopes for the effects of picture valence, picture relevance, and by-picture random slopes for the effects of age group, culture group, and mood condition.

To examine our hypothesis of cultural difference in the presence of age-related positivity effect at the preference level and the roles of emotional valence and cultural relevance, we particularly focused on the three-way interaction of picture valence × age × culture, which was found to be significant, $\beta = 2.29$, $SE = 1.10$, $t(544) = 2.08$, $p < .05$ (see Figure 1). The interaction was not significantly moderated by other factors, and all other main and interaction effects did not reach significance (ps > .05). Simple slope analyses following up on the interaction revealed an age-related positivity effect within the US sample, that is, older adults showed more gaze preference for more positively valenced pictures compared to younger adults; in contrast, within the Hong Kong sample, older adults showed less gaze preference for more positively valenced pictures compared to younger adults. The results showed an age-related positivity effect on gaze preference within the US sample, but not within the Hong Kong sample.

Mood as the Outcome of Gaze Fixation (Effectiveness)

A cross-random multi-level model was built to examine how gaze fixation on pictures predicted outcome mood. Fixed effects in this model included the main effects and all interactions of picture valence, picture culture, fixation duration percentage, age, participant culture, and mood condition. The main effects of picture arousal and AOI ratio were also included as fixed effects to be controlled for. Random effects included inter-participant variance in intercepts and slopes of picture valence, and picture arousal, as well as inter-picture variance in intercept and slope mood condition.

The results showed a significant main effect of picture valence, $\beta = .56$, $SE = .08$, $t(39) = 7.83$, $p < .001$, indicating that mood valence after viewing positive pictures was more positive compared to mood valence after viewing negative pictures. There was also a significant 6-way interaction, with covariates (i.e., cognitive ability, FTP, cognitive reappraisal, physical symptom, and baseline mood valence before mood-induction) controlled for, $\beta = -.01$, $SE = .005$, $t(6430) = -2.19$, $p < .05$, or not controlled for, $\beta = -.01$, $SE = .005$, $t(6428) = -2.24$, $p < .05$. We decomposed the 6-way interaction on the basis of our hypotheses to examine the effect of fixation duration percentage on mood valence. To be specific, we examined the effects of fixation duration percentage on mood valence among younger and older adults separately for each culture (US vs. Hong Kong Chinese) × mood condition (negative-mood vs. neutral-mood condition) cell (see Figure 2). In the US sample, the main effect of fixation duration percentage and all interaction effects with fixation duration percentage involved were non-significant (ps > .10). In the Hong Kong Chinese sample, the effect of fixation duration percentage was significant only for older adults under the neutral-mood condition, and the effect was moderated by picture valence, as revealed by a significant fixation duration percentage × picture valence interaction (regardless of picture relevance), $\beta = .004$, $SE = .002$, $t(496) = 2.44$, $p < .05$, which

indicated that longer gaze at more positive (vs. more negative) pictures predicted more positive mood. The fixation duration percentage × picture valence interaction pattern remained the same even after statistically controlled for the covariates (cognitive ability, cognitive reappraisal, physical symptom, and baseline mood valence before mood-induction, $\beta = .004$, $SE = .002$, $t(494) = 2.56$, $p < .05$. These results, taken together, showed an age-related positivity effect at the effectiveness level among the Hong Kong Chinese sample, but not among the US American sample, that is, longer fixation on positive pictures enhanced positive mood to a larger degree among older versus younger Hong Kong Chinese in the neutral-mood condition.

Discussion

The age-related positivity effect, which was quite commonly found in the US (see Scheibe & Carstensen, 2010 for a review) was replicated in East Asian cultures in some studies (e.g., Chung & Lin, 2012; Gong et al., 2014; Ko et al., 2011; Kwon et al., 2009; Wang et al., 2015; Zhang et al., 2016), but not others (Fung et al., 2008; Fung & Tang, 2005). This study attempted to shed light on this controversy by testing the roles of cultural relevance in the age-related positivity effect. It also tested whether there would be cultural differences in different processes associated with the age-related positivity effect. In terms of showing attentional *preferences* toward more positively valenced and more culturally relevant pictures, we predicted that Hong Kong older adults would do so to a lesser extent than US older adults would, relative to their younger counterparts. In contrast, in terms of the *effectiveness* of showing more positive mood changes with greater attention toward more positively valenced and more culturally relevant pictures, we predicted that Hong Kong older adults would do so to a greater extent than US older adults would, relative to their younger counterparts.

The results of our manipulation checks suggested that European Americans did find Western pictures (original pictures from the IAPS; Lang et al., 1999) more culturally relevant and Chinese did find Chinese pictures of equivalent content, valence and arousal levels as the Western pictures more culturally relevant. Despite this, cultural relevance did not moderate age differences in attentional preferences in either our US or Hong Kong sample. Among US Americans, older adults showed *more* attentional preference toward pictures of more positive valence, compared with younger adults. Cultural relevance did not moderate these age differences. Likewise, among Hong Kong Chinese, older adults showed *less* attentional preference toward pictures of more positive valence, regardless of cultural relevance, compared with younger adults. These results are consistent with prior findings that there is an age-related positivity effect on gaze preference among US Americans (e.g., Isaacowitz et al., 2006), but no such effect, or even a reverse effect, among Hong Kong Chinese (e.g., Fung et al., 2008).

Importantly, making the stimuli more culturally relevant did not seem to influence these age differences in gaze preference. In spite of the literature on how self-relevant and culturally relevant information is prioritized in human cognition (Brewer, 1991; Turner & Reynolds, 2010), cultural relevance does not seem to occur for cultural differences in the age-related positivity effect. It could be possible that emotional valence played a more important role compared to cultural relevance in the age-related positivity effect, which contradicted our hypothesis. It could also be possible that the meaningfulness of the culturally relevant pictures was not strong enough, and the difference of meaningfulness between culturally relevant versus irrelevant pictures was not sufficiently salient. Social-identity-relevance (e.g., cultural relevance) is an extension of self-relevance (e.g., Hong et al., 2001), and it is usually cognitively prioritized to a lower degree compared to self-relevance (Lee et al., 2015; Leshikar & Gutchess, 2015). To distinguish

between these two possibilities and to further clarify the roles of emotional valence and meaningfulness, studies with more rigorous manipulation of these two factors are desired.

What seems to account for cultural differences in the age-related positivity effect is whether we are studying attention preferences or the effectiveness of using such preferences to achieve an emotional outcome. For the former, as reported above, US Americans showed the age-related positivity effect in the preference process (i.e., longer gaze at positive pictures). In contrast, among Hong Kong Chinese, older adults did not gaze more at more positively valenced pictures than did younger adults; in fact, they gazed less. But when they did so, gazing more at more positively valenced pictures predicted more positive mood changes for them, more so than did their younger counterparts, in the neutral-mood condition; US Americans did not show these age differences. The results support our hypothesis that an age-related positivity effect at the effectiveness level is more likely to happen in Hong Kong Chinese, but not in US Americans.

However, contrast to our hypothesis that the age-related positivity effect would be more likely to be detected in the negative-mood induction condition, we found the effect in the neutral-mood condition, but not in the negative-mood condition. One possible reason was that negative-mood induction might have increased emotion-regulation motivation for everyone, reducing age differences. The literature (e.g., the SST and relevant research) documents that older adults (usually older Westerners in this research) are automatically (under natural state without experimental manipulation) motivated to regulate emotion and to seek positive affect (e.g., for a review see Mather, 2006). However, when experimental manipulations (e.g., manipulation of task goal or cognitive resources) were applied, the age-related positivity effect usually diminished or vanished, probably because the manipulation activated the same motivation in younger and older adults (e.g., Fung & Carstensen, 2003; Kennedy et al., 2004; Light &

Isaacowitz, 2006; Löckenhoff & Carstensen, 2007; Mikels et al., 2010; Pruzan & Isaacowitz, 2006).

Some may argue that the cultural differences in age effects at the effectiveness level could be confounded by a context effect. The effectiveness (of emotion regulation) was assessed on a trial-by-trial basis after participants watched each picture in the current study. East Asians with holistic processing style have a stronger tendency to integrate background context during information processing compared to Westerners with analytic processing style (Masuda & Nisbett, 2001; Nisbett & Miyamoto, 2005). Given this, one may argue that Chinese (vs. US) older adults might be more primed by the preceding picture, and they were thus more likely to think about the emotional valence of the picture when they evaluate their own mood, leading to a greater corresponding mood change. On the one hand, such influence, if it exists, might have affected the two age groups and the two mood conditions similarly. The fact that we found cultural differences in the association between gaze fixation and mood changes only for older adults in the neutral-mood condition makes a general context effect unlikely. On the other hand, we acknowledge that cultural differences in the context effect, should it occur, might be larger in older than in young adults, given their longer cultural exposure (e.g., Yang, Chen, Ng, & Fu, 2013). Future studies should look further into this possibility.

Taken together, these findings suggest that better mood can be achieved in two ways in the realm of visual attention: (1) by gazing at positively valenced stimuli more; and (2) by gaining more mood benefits from the gaze. Similar to prior findings on expressive suppression (Gross & John, 2003; Yeung & Fung, 2012), US Americans seem to use the first way to achieve better mood with age whereas Hong Kong Chinese seem to use the second way. As for why the two cultural groups choose their respective ways to regulate emotions with age, we can only

speculate that this may be attributable to the fact that while US Americans value the pleasantness of an emotional experience more (Sim et al., 2015), Chinese may value the usefulness of the emotional experience more (Tamir & Ford, 2012). Future studies should test whether cultural differences in the age-related positivity effect can be altered by manipulating these two values.

We acknowledge several limitations for this study. First, we compared younger and older adults in a cross-sectional manner. The age differences we observed could be due to cohort effects in addition to or instead of developmental changes. Second, we only sampled from one city in the US and one city in China. Although the cities that we chose, Boston and Hong Kong, are similar in terms of demographic characteristics, economic development and metropolitan level, further studies are needed to test whether the cultural differences we found are specific to the two cities or generalizable to US Americans and Chinese in general. Moreover, future studies should also examine the generalizability of the cultural differences in other countries. Third, our analyses revealed that mood manipulation and cognitive abilities did not influence the association between gaze preferences and mood changes for US Americans. This is not consistent with prior studies using similar paradigms (Isaacowitz et al., 2009; Noh et al., 2011). Further studies should explore whether the inconsistent findings were due to technical issues such as differences in stimuli, or more conceptual mechanisms such as whether emotion regulation (i.e., the need to lift negative mood) or affect valuation (i.e., the value of particular affective stimuli without the need to repair mood) is driving the effects. Fourth, we focused on participants' fixation on AOIs and largely ignored the peripheral information out of AOIs. The peripheral information, however, could be related to emotion. It is difficult to exclude the possibility that some contextual information might be used as clues by the participant to interpret the emotionality of the pictures.

Despite these limitations, this study followed up on our prior work on cultural differences in the age-related positivity effect (e.g., Fung et al., 2008). Our findings suggest that while US Americans show the age-related positivity effect in terms of their attentional preferences for positively valenced stimuli, Hong Kong Chinese show the age-related positivity effect in terms of effectiveness.

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Table 1. Chinese and US Participants' Ratings (*M*±*SD*) for the Affective Pictures

		Chinese pictures			Western pictures		
		positive	neutral	negative	positive	neutral	negative
Chinese	valence	6.13±.91	5.05±.25	3.32±.49	6.64±.43	4.84±.24	3.72±.85
participants	arousal	5.02±.83	4.06±.32	4.02±.58	5.52±.46	3.81±.27	4.02±.55
	culture	6.13±1.27	7.35±.97	6.15±.66	3.26±.71	4.53±1.29	3.68±.31
US	valence	6.80±.81	5.49±.65	3.93±.74	7.27±.34	4.93±.47	3.36±.97
Participants	arousal	4.39±1.08	3.83±64	4.42±.75	4.54±1.03	3.67±.37	4.91±1.48
	culture	6.44±.91	6.92±.80	6.03±.97	3.08±.73	4.20±.83	3.35±.34

Notes. Ratings were done on a scale from 1 to 9 for the following dimensions: valence (1 = "unhappy" to 9 = "happy"), arousal (1 = "calm" to 9 = "excited"), and cultural relevance (1 = "relevant to Western culture" to 9 = "relevant to Chinese culture").

Table 2. Sample Characteristics (*M* ± *SD*) for the Chinese and US Younger and Older Adults

	Younger Chinese	Older Chinese	Younger US	Older US
Visual acuity	.74 ± 1.42	-.05 ± 1.48	.90 ± 1.15	-1.32 ± 1.52
Cognitive ability	7.54 ± 1.74	6.75 ± 1.54	6.07 ± 1.09	6.02 ± 1.53
FTP	4.43 ± .67	3.80 ± .89	5.53 ± .73	4.72 ± 1.22
Cognitive reappraisal	5.08 ± .72	5.13 ± .79	5.02 ± 1.01	5.34 ± 1.09
Expression suppression	4.36 ± 1.03	4.51 ± 1.05	3.69 ± 1.24	3.08 ± 1.33
Interdependent self	3.68 ± .40	4.21 ± .64	3.74 ± .48	3.42 ± .70
Independent self	3.77 ± .37	3.88 ± .46	4.18 ± .44	4.16 ± .48
Physical symptom	1.89 ± .64	.79 ± .52	1.83 ± .47	1.81 ± .62
Subjective health	2.73 ± .92	2.79 ± .91	3..60 ± .98	3.59 ± .98
VIA_own culture	7.33 ± .81	6.67 ± .96	7.39 ± 1.30	7.12 ± 1.52
VIA_other culture	5.76 ± .95	3.61 ± 1.53	4.58 ± 1.48	4.50 ± 1.64
Pre-induction mood (negative condition)	3.90 ± .70	3.23 ± .68	4.00 ± .69	3.63 ± .96
Pre-induction mood (neutral condition)	3.76 ± .66	3.39 ± .67	3.54 ± .77	3.58 ± .96
Post-induction mood (negative condition)	1.65 ± .49	1.53 ± .51	1.62 ± .49	1.52 ± .50
Post-induction mood (neutral condition)	4.12 ± .53	4.06 ± .73	4.27 ± .84	4.29 ± .87

Note. Visual acuity: the sum of the standardized score on the Snellen chart and the standardized score on the Pelli-Robson Contrast Sensitivity Chart; FTP = future time perspective; VIA = Vancouver index of acculturation.

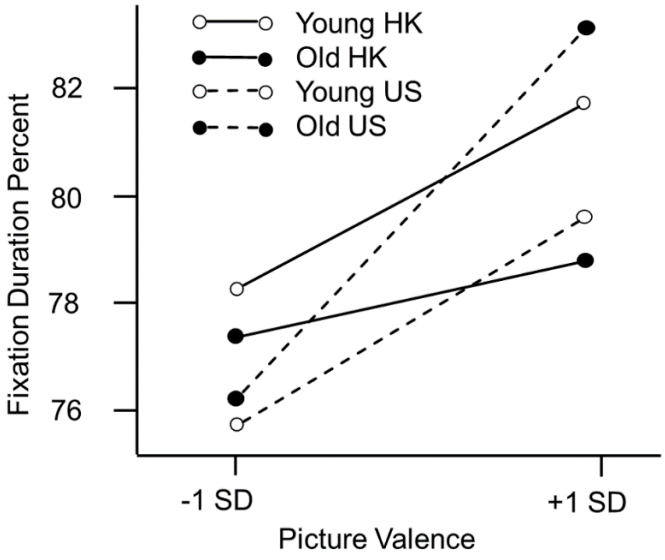

Figure 1. Fixation duration percentage as a function of picture valence rating (plotted at $\pm$1 *SD;* higher ratings indicate higher levels of positivity) within Hong Kong and US younger and older participants.

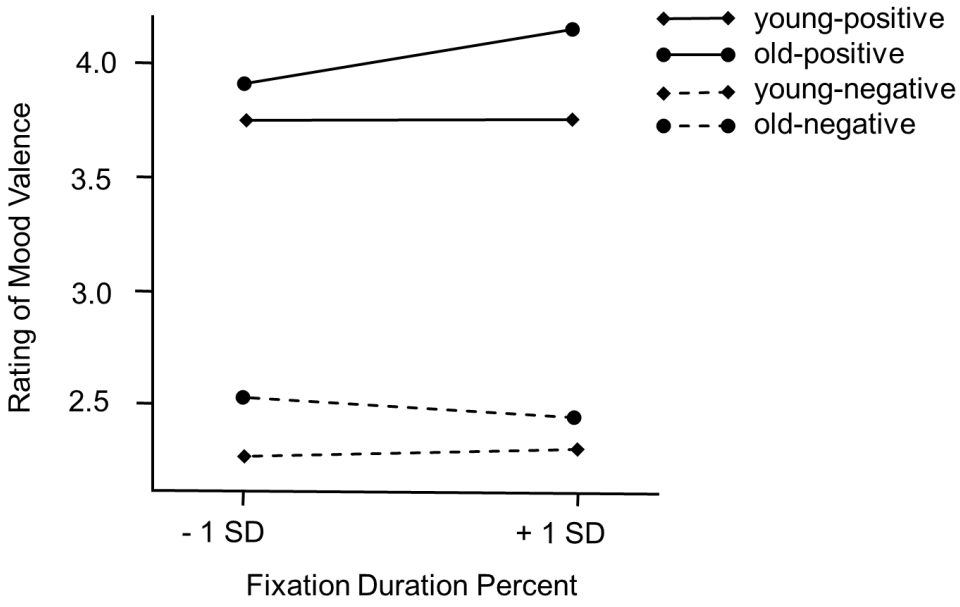

Figure 2. Mood valence as a function of fixation duration percentage (plotted at $\pm$1 *SD*) on pictures with different levels of emotional valence (plotted at $\pm$1 *SD*) among younger and older Hong Kong Chinese under the neutral-mood condition.